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LARGE MOLECULES IN SCIENCE AND LIFE[1]

By Professor HUGH S. TAYLOR
PRINCETON UNIVERSITY

IT is a striking characteristic of the gaseous substance, acetylene, with which Father Nieuwland spent so much of his later scientific life, that, under the influence of a variety of agencies, light, radioactive rays, cathode rays, the silent electric discharge and, also, even contact agents such as a copper catalyst, the gas changes to an insoluble yellowish solid known as cuprene. It received its name because Sabatier, who prepared it from acetylene with the aid of a copper catalyst, thought that it contained copper. It is now known that it contains no copper, but, within the error of analysis, a one to one ratio of carbon to hydrogen, as does acetylene. How different the properties! In place of a highly reactive gas we have a chemically inert solid, the linkages of which are all so mutually satisfied that it has hitherto resisted all efforts to bring it into solution in any known solvent, although hundreds of such have been tried. All the properties of the simple molecule, with the study of which Father Nieuwland spent so many happy and fruitful days, have disappeared in the formation of something which we may speak of as giant molecules, each particle of the cuprene composed of three-dimensional arrays of the carbon and hydrogen atoms of which it is composed. Acetylene is the simplest of the compounds from which, in these hectic days of industrial scientific progress, large molecules or polymers, with a fascinating range of properties, may be prepared, synthetic rubbers, plastics, fibers and the like.

It is not alone, however, in the industrial scientific field that the large polymeric molecules possess great significance. In biological systems and in organic matter generally, it is now known that highly polymerized systems constitute an important fraction of such material and that their properties, including tensile strength, elasticity and flexibility, durability, resistance to chemical change, hardness, confer on such bodies a

[1] An address delivered at the Father Nieuwland Memorial Exercises at the University of Notre Dame on January 10, 1937.

wide variation of desirable properties. In inorganic systems also, as in diamond and graphite, silica and the silicates, including varieties with such divergent properties as crystal quartz, mica sheets, asbestos fibers, we find examples multiplied of the manifold properties which may be conferred on material of the same unitary composition when built up by repetition of the unit in one, two or three dimensions into the larger aggregates of naturally occurring minerals and products.

Science to-day is facing boldly the difficult problems that the investigation of such complexities of structure bring in their train. The wonderful achievements in the organic chemistry of biologically important compounds with the syntheses of such substances as the vitamins and hormones can not obscure the fact that the problems that still lie ahead, involving the molecules of an entirely higher order of complexity, the proteins, the viruses, enzymes, cellulose, require for their solution the best cooperative efforts of the biologist, the physicist, the organic and inorganic chemist; nor is it beyond the bounds of possibility that the mathematician with his specialized knowledge in the field of topology will also be called in to assist. Only in special cases will the ordinary synthetic and analytic studies of classical organic chemistry suffice for the problem in hand. Greater progress will occur when such is combined with kinetic, stereo-analytical and colloidal techniques that the other sciences will contribute.

In the field of inorganic matter it is the diffraction of x-rays by solid matter that has been, in the past two decades, so intensely revealing. These rays of light, commensurable in wave-length with the distances between atoms in the solid structures studied, have revealed the diamond, hardest of known substances, as a tetrahedral array of carbon atoms in one giant molecule, each atom equally spaced from four neighbors arranged at the corners of a tetrahedron of which the fifth atom occupies the center. The distance from carbon atom to carbon is identical with that between carbon atoms in the paraffinic hydrocarbons of a straight run Pennsylvania gasoline, with about the same energy of bonding. This is a strong bond, and it is the symmetry of this bonding in all directions throughout the diamond aggregate that confers upon it its two conspicuous properties, its intense hardness and its lack of volatility. In graphite, this symmetry is destroyed and the analysis of the atom spacing reveals the causes of the new properties. There is a hexagonal array of carbon atoms in flat planes similarly spaced to the carbon atoms in a benzene ring, but between planes the distance is from two to three times that between atoms in the ring. It is along this plane of great distance that cleavage can occur, accounting simply for the flaky characteristics of the mineral.

In crystal quartz and in the silicates, the x-ray reveals a similar regularity of architecture. The silicon atom in this case is always located between four oxygen atoms. In certain silicates, this array of five atoms, SiO_4, forms a tetrahedral array similar to that discussed in the case of diamond. The oxygen atoms may, however, act as bridges between two silicon atoms and numerous possibilities result. Two tetrahedra may be linked through one common oxygen atom which is common to two silicons and form a unit, Si_2O_7, to build into a more complex structure with other units. Three may form a ring, Si_3O_9, and six may form another type of ring, Si_6O_{18}. If the edges of two tetrahedra are linked by two common oxygen atoms a chain or filament or fiber, with a formula $(SiO_3)_n$, where n may be indefinitely long, is formed. Two chains linked side by side give a band of which the unit composition is Si_4O_{11}. Sheets, like mica, belong to the class of linked tetrahedra, each tetrahedron sharing three corners, with composition $(Si_2O_5)_n$. If all four corners are shared with other tetrahedra (as in diamond) the extension occurs in three dimensions, crystal quartz results and the composition is a giant molecule $(SiO_2)_n$.

Alumina can replace silicon in these structures, the tetrahedron acquires a negative charge and so can associate in the crystal architecture with positive metal units. The felspars are of this structure. Zeolites, such as permutit, are more open structures containing water molecules within the crystal architecture; these open structures permit replacement of the positive units, a circumstance which determines their use for water softening.

From such deductions based upon x-ray analysis of inorganic matter there is a ready transition to the corresponding structures in naturally occurring and synthetic organic materials. The continuous linkages of molecules having one reactive group at each end will give rise to linear aggregates, filamentary or chain-like in character. Under favorable circumstances this type of reaction may give rise to ring formation or cyclization, with alternative spacial configurations of the resultant products. Molecules with a greater number of reactive units in the initial structure, so-called polyfunctional molecules, offer greater varieties of structural growth, extending into three dimensions. Acetylene may be regarded as having four-fold functionality and the cuprene would represent a three-dimensional growth of the aggregate. Divinyl acetylene, on the other hand, $CH_2 = CH - C \equiv C - CH = CH_2$, illustrates the acetylene molecule in process of linear growth, with only half of its unsaturation contributing to the change. Oxygen, sulfur and nitrogen are important atom links in such aggregates of large organic molecules. Sulfur atoms are important links in the chains of atoms present in the technically important "thiokol."

The study of jellies, and of the gels which result

from them by controlled removal of the water content, represents another avenue of approach to the problems of large molecules employing the technique of the colloidal chemist. Here also x-ray investigations are an invaluable supplement to the physico-chemical studies of such structures. They reveal the structure or its absence in the aggregates obtained. Completely amorphous, crystalline and half-crystalline structures have been observed. The physical characteristics of the jelly undoubtedly depend on the same type of orienting forces, if quantitatively less strong, as are involved in the building up of the more robust structures. The zeolites may be thought of as a half-way house between the jelly and the large-molecule crystal.

The techniques of colloid-chemistry are invaluable also in the determination of the distribution of sizes amongst the polymer aggregates. In this regard, mainly due to the brilliant leadership of Svedberg, our knowledge is rapidly growing. By measurements of the rate of settling of the particles dispersed in a suitable liquid medium, either under the action of gravity or under the influence of centrifugal forces which may rise to many tens of thousands of times the force of gravity, we can learn whether the individual particles of a product, natural or synthetic, are uniform or non-uniform. If uniform, the rate of settling will be uniform and reveal itself as sharp-edged sedimentation. If the material be non-uniform, the lighter particles settle more slowly and a blurred boundary is obtained in the process. Size-classifications can be obtained in the latter case. The outstanding results of such studies by Svedberg and his collaborators lie, however, in the observations made with naturally occurring proteins, many of which, after suitable purification and under stable conditions, are found to be remarkably uniform in size. This implies that the units are identical chemically, are, indeed, single macromolecules. Svedberg's researches reveal, moreover, that the molecular weights of different proteins show a surprisingly simple relationship with one another. One series of proteins have a molecular weight of about 34,500. Another group have a value of about 68,000; a third averages 104,000, another group 208,000. Some have molecular weights of as high as 5,000,000.

In the general field of the large molecules, included under the term protein, the greatest scientific activity now obtains. Here, at its best, is exemplified, at the moment, that cooperative international effort in science in such marked contrast to the divisive, competitive struggles that separate nations in other fields. A great concentration of skills is being brought to bear upon the problem. The shapes and sizes and surface properties are being studied by observations of insoluble protein films on water. The velocities of protein reactions are being followed, practically and theoretically, in an effort to elucidate the mechanisms of interaction. Stanley's studies of the crystalline tobacco leaf virus are revealing the conditions necessary to the multiplication of protein material. Crystalline pepsin and trypsin, typical protein enzymes are steadily compelled to reveal the complexities of their structure and behavior. More recently still, from the ranks of the mathematician, from a topographical approach, Dr. Wrinch is discussing the pattern of protein structure, two-dimensional cyclol layers capable of extension in three dimensions by linkage front to front and back to back by side chains and hydroxyls, respectively, in a manner made familiar by the study of Langmuir and Miss Blodgett with oil films on saturated barium carbonate solutions. The pattern of the protein surface is being linked with the structure of the physiologically active substances, such as the carcinogens, sterols, sex hormones, as the substrate on which these latter may be superposed. Finally, the same protein pattern may be built up into closed globular structures which would define the uniformity of molecular weight determined by Svedberg in his studies and the particular magnitudes for these weights which the measurements reveal. All these varying techniques are available to assist the synthetic organic chemist in the development of his own rich efforts, so well exemplified in the person of him who to-day we have come from near and far to honor.

ENGINEERING IN AN AMERICAN PROGRAM FOR SOCIAL PROGRESS.[1] II

By Dr. KARL T. COMPTON
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CONSERVATION OF NATURAL RESOURCES

We turn now to the third great feature of the American program for social progress, which is the conservation of our natural resources. To this end the Federal Administration has maintained a National Resources Committee which has made an extensive survey into every aspect of national resources, including soil, water, minerals, timber, waterways and even manpower. There can be nothing but approval of this

[1] Address on Commemoration Day at the Johns Hopkins University, February 22, 1937, celebrating the twenty-fifth anniversary of the founding of the School of Engineering at the Johns Hopkins University.

crystallization of effort to survey our situation with regard to natural resources for the purpose of developing a program which will conserve and use them for the best ultimate public interest. It is another step in that succession of moves in the same direction which have occurred since the time when this country first realized that its natural resources were not unlimited and must, therefore, be husbanded and used with wisdom.

Among the specific activities which have been undertaken under this general heading and which are in various stages of completion are the large number of construction projects under the Public Works Administration and related agencies, together with some special services in other bureaus. They range all the way from the St. Lawrence Waterway Project, which has not been authorized and remains in the controversial stage as to its economic desirability, to the work of the Tennessee Valley Authority, which is in an advanced stage of operation. Other such activities are the Soil Erosion Service, the Shelter Belt, the Mississippi Valley Commission, the Passamaquoddy Tidal Project, Grand Coulee and Bonneville Dams, oil production control, and so forth.

As scientists and engineers, our reactions to these various projects are probably diverse. At the bottom of the list in merit I would place the Shelter Belt, which was a grand emotional gesture, but whose conception in large part neglected essential scientific facts both of ecology and of aerodynamics. Somewhat higher in the list would be the Passamaquoddy Project, of undoubted engineering interest but economically unjustified. The Tennessee Valley Authority Project is undoubtedly accomplishing much of public value and will be a useful experiment, provided its results will be interpreted in accordance with the facts, as the engineer would objectively analyze them, and are not misrepresented for the political purposes of justifying past actions or of promoting future policies. Unfortunately, the records already contain some evidence that such abuse of the truth for ulterior purposes has already been practiced in this otherwise great engineering venture. Of highest value in the list I should place the Soil Erosion Service and the Oil Production Control, since a wise prosecution of the former will undoubtedly be of enormous ultimate benefit to our agriculture, and the administration of the latter is in aid of conservation of our oil reserves through elimination of some of the economic pressure to wasteful production.

Note the significant fact that nearly every aspect of this program of conservation of natural resources is an engineering job. I venture to suggest that the country may soon be in a position to draw a very important lesson in regard to the projects of the type which I have mentioned. Every one of them is interesting and is aimed at some valuable goal. From all the work which will be done on them, there will undoubtedly emerge much constructive improvement of the physical plant of our country. The great question to be answered, however, is whether the economic and social results of this great program have justified the expense; or, in other words, has the program been efficiently conceived and carried through? When these questions are examined, the criterion will be the analysis of the engineer; and I suspect that the answer will contain the conclusion that it will always be very much to the best interests of the country to have the decisions as to such programs made with more attention to the judgment of the engineer than has in the past been true.

Another important aspect of the rôle of the engineer in the conservation of our natural resources is well illustrated in the case of petroleum. For years there have been various estimates of the time in which our oil reserves will be exhausted. With every passing year we know more about the amount of oil which is still in the ground because of the continual surveys by improved methods to locate new oil fields. Consequently, it is safe to say that the present estimates are the most accurate which we have ever had.

In the recent annual report to the stockholders of one of the great oil companies, a company whose traditional policy has been to deprecate fear of early oil exhaustion, it was stated that the oil in sight in this country is sufficient to supply the present rate of demand for a little over twelve years. How much new oil may be discovered before this twelve years are past no one can foretell, but I believe that all experts now agree that the oil supply in the United States will begin to show shortage well within our lifetime.

Oil has become so important in the economy of the country that it is of tremendous importance to find some substitute fuel before oil becomes scarce. What the best substitute fuel will be is a question for the scientist and the research engineer to answer. Perhaps the two most promising fuels in sight are alcohol from agricultural products or hydrocarbons produced by hydrogenation of coal. For the public interest it is very important for the engineer to develop such fuels and to design engines adaptable to these different fuels in order that this important problem of fuels for automotive engines may be well solved by the time the need is pressing.

So we see that the engineer is involved in important ways both in the direct conservation of natural resources and also in the provision for the country's needs when these resources shall have been exhausted.

Housing

There seems to be general agreement that a notable improvement in the social conditions of the country

ll come through a great housing program. Statistics ow a real pressure for new homes. Sociologists and onomists can easily demonstrate the great advantages moral, spiritual and physical welfare which would llow a housing program wisely administered. There no other work project which would give such a good stribution of employment and stimulation of indusy, since it includes the heavy industries, equipment dustries, transportation, skilled labor in the building ade and unskilled labor. The Federal Government, rough its Federal Housing Administration, has exted strong efforts to get a large housing program nder way. Something has been accomplished, but on e whole the program has been disappointingly slow d ineffective. Nevertheless, I think there are few eople who have studied the situation who do not elieve firmly in the social advantage and the inevitable pproach of a great program along these lines.

Fundamentally there are two aspects to the housing rogram on which its success will depend. The one volves the town or city planner and the other involves e engineer, although these two functions can not be ntirely separated. The city planner must view with e eyes of a sociologist, a welfare worker, an econoist, an engineer, a politician and a prophet those ircumstances which determine where people should ve, where people can live and what will be the future ends. He must consider such trends as the exodus f industry from the north to the south, or the east o the west, or the crowded city to the suburban community; he must make a practical estimate of how uch the community will be willing to pay in the form f subsidy in rebuilding a slum district because of ivic pride or humanitarian instincts, combined with e saving which will be secured in the administration f public health and law. This relatively new profession of the city planner is one in which the engineer, the architect and the sociologist all play cooperating rôles.

But in the last analysis the question of building houses or not building houses is an economic one and depends on the answer to the question: Can the houses be built of such a type and for such a price that they can be sold or rented at a reasonable profit? The answer to this question is definitely in the hands of the engineer, for it is the success of his work which determines the materials which will be used for construction, the methods employed in erection and the nature of the supplementary services of heating, ventilating, gas, electricity and plumbing. In private home construction there has been surprisingly little change in fundamental materials or methods since the earliest days, and there is strong reason for believing that ways will be developed for introducing into home construction some of the features which have made it possible for the ordinary man to buy, for $500 or $600, an automobile which, according to ordinary standards of excellence, ought to sell for several thousand dollars. If the engineer can make progress along these lines in the field of housing, then there is no doubt but that the flood gates will be opened and this country will see a tremendous boom in building construction.

This program is not an easy one, for there are many difficulties to be overcome. One is the inertia of habit and tradition which holds us to a certain notion of how and where people should live, even though this notion is indefensible by the logic of the present situation. Another difficulty may be with organized labor, which is so strongly entrenched in the building trades as perhaps to form a powerful obstacle to the introduction of any method of building construction which would partake more of the nature of erection than of traditional building. But most important of all is the fact that satisfactory success has not yet been attained in the search for materials and methods which will provide an entirely satisfactory house, one which does not look cheap, which will actually stand the wear and tear, which is solid enough to give the desirable feeling of security and privacy and which can be built more conveniently than the present home but at a notably lower cost. Here is undoubtedly a great challenge for the engineer.

DISTRIBUTION

Another element in the American program for social progress is the search for more efficient methods of distribution of the products of agriculture and industry. This is not a problem which has been notably stressed during the emergencies of the late depression, but it is one of which the American people have been conscious for many years. Its significance is brought out by a comparison of the price paid by the consumer for his foodstuffs or home equipment or clothing as over against the price which is received by the farmer or the manufacturer who produces these articles. Such comparisons show that the cost of distribution is generally a major portion of the price which we pay.

The answer to this problem has not been found, although progress has been made. For example, the federal coordinator of transportation has urged increased efficiency in distribution over the railroads through consolidation and better planning of terminal facilities. The great increase in number and popularity of chain stores for distribution of household necessities and the success of the large mail-order houses are due to their contribution toward the solution of this great problem. Perhaps the most basic feature for securing the best possible solution to this problem is the maintenance of free competition, so that the man or the company who can discover a method of cutting the

costs of distribution will be financially rewarded for his efforts. Government assumption of the rôle of distributor would probably be the worst solution. If industrial codes should ever again be established, one important consideration is that they should leave the way open for the stimulation and encouragement to increased efficiency through some financial advantage to any organization which can find a means of reducing the cost of products to the consuming public.

There are many ways in which the engineer can contribute to this problem. One of these, of course, is through increasing the efficiency of the means of transportation by rail, highway and air. Another is through improvement in the methods of packaging and the discovery of large-scale methods for preserving perishable goods. Still another is in the development of methods for easy storage and for quick handling of goods. Thus there is scope not only for the "Simon pure" engineer, mechanical and electrical, for example, but also for the so-called efficiency engineer who operates by somewhat the same methods of logic.

Higher Standards of Living

And now I come to the last feature which I will discuss in the American program for social progress, and it is the one which is probably most prominently now in the minds of the American public. It is the effort to secure higher wages, shorter hours of labor and a generally higher standard of living.

When we consider wages, hours and standard of living, we find on analysis that there are two approaches to the desired objective in these matters. The one approach is through distribution and the other through creation. The former is a matter of legislation and negotiation, while the latter is primarily the responsibility of the engineer.

Let me illustrate this analysis by considering wages. Every worker desires the highest possible wage which he can secure. This is perfectly natural. The easiest and most direct way for him to get this is to try to take it away from some one else. This is the traditional method, which goes back to the dawn of history and has been the basic philosophy of wars, conquests, strikes and demagoguery in politics. On humanitarian grounds there has been much to defend this philosophy, because, also from time immemorial, we have had the picture of the strong oppressing the weak and the rich becoming richer at the expense of the poor. It is undoubtedly good and proper social philosophy and for the ultimate best interests of the human race that profit and wealth be distributed more evenly than has been the general tendency of the past.

A closer analysis of the situation, however, discloses the fact that there are definite limits and decided dangers in carrying this policy too far. The limits are disclosed by a survey of the amount of wealth or the amount of profit which is available for distribution. Thus it is found that the total amount of wealth or the total amount of profit, if distributed uniformly over the population, would raise the wealth or the income of the mass of workers by a disappointingly small amount. Furthermore, there would be a great danger in carrying this tendency too far, because to do so would dry up those sources of financial support which have proved to be the most potent means of creating new industry, providing new jobs and new profit. An extreme state of socialization involving more or less uniform distribution of wealth would certainly become very rapidly a state of stagnation in so far as progress is concerned and might very well become a state of retrogression.

This tendency of a movement toward a desired objective to set in motion forces which tend to counteract that objective is a social analogy of a well-known law of thermodynamics (Clapeyron) according to which any action sets up forces which tend to counteract it.

Therefore, while we can say that while a certain degree of distribution of wealth and profit is in the best public interest and is proper on ethical, economic and humanitarian grounds, nevertheless this approach to higher wages has its definite limitations and, if carried too far, brings serious dangers. Consider, therefore, the alternative of creating higher wages through the creation of new wealth by engineering methods.

Engineering methods in industry tend to raise wages by creation of new wealth in two different ways. One of these, which is the most direct and easily understood, is the development of new industries which directly provide new products, new employment and new profits. These industries depend upon inventive and engineering skill of a creative type. The other method is less direct and is sometimes misunderstood, as it was in the discussions of technocracy a few years ago. This indirect method operates as follows.

One function of the engineer is to discover the most convenient and economical method of doing the things which are desired to be done. Thus he creates labor-saving and quantity production devices whose first effect may be to throw people out of work through producing a given amount of goods with less labor. It is general experience, however, that this method of production so lowers the cost of goods that the market for the goods is enormously increased and the net result is far more labor at higher wages and with more profit than would have been possible without the introduction of the labor-saving and quantity production machinery. The assembly line in the automobile factory has not only made the automobile available to every class of person in the country, but it has resulted in creating one of the two or three largest lines of employment in

the country at next to the highest wage paid in any large industry. Similarly, it was the introduction of machine methods of building incandescent lamps that made these lamps so cheap that they have become universal lighting fixtures, providing again large employment in manufacture and distribution at a relatively high wage-scale.

Along with these higher wages there have come shorter hours of labor, which would never in the world have been possible except by the development of quantity producing machinery, which has enabled the human race to supply its necessities and its luxuries in a sufficiently short working day to leave time for education, recreation, old-age pensions and other advantages which are only possible to the extent that engineering developments increase productive power.

The ideal community, therefore, which we might call the "analogue of Plato's republic" expressed in terms of modern technique, would be a community in which all work is performed as easily and quickly as possible, and in which there are enough things to contribute to desires beyond the bare necessities of life to provide a proper amount of general employment. In this ideal community the increased profits due to engineering efficiency would be split three ways: between the wage-earner, the owner and the consumer.

In these days of agitation for higher wages and shorter hours and a higher standard of living, it is important to remember the fundamental fact that it is only efficiency of production through engineering methods which makes general improvement in these lines possible.

Having thus discussed the rôle of the engineer with reference to some of the best recognized elements in the American program for social progress, let me turn briefly to the consideration of another problem which is fundamentally related to these and to all activities in our national life. I refer to the problem of leadership.

It is a rather discouraging and frequently startling situation in which we so often have to admit that proper leadership is lacking and is apparently unavailable. One could very well take the ground, therefore, that in all the elements of the American program for social progress there is fundamentally involved the problem of developing leaders. What contribution does the field of engineering make to the solution of this human problem?

I can suggest an answer to this question quite briefly and very definitely by quoting from statistics which have been gathered by the director of the General Motors Institute, Mr. Robert H. Spahr, in connection with a report three or four years ago to the Society for the Promotion of Engineering Education. This survey of the officers of companies in American industry showed the startling fact that graduates of engineering or technical colleges are many times more likely to be found in positions of authority than are graduates of other types of colleges or non-college men. For example, out of the 235 college-trained presidents in leading American industries, 151 were trained in engineering or technical colleges, and 84 in colleges of all other types. When we consider the fact that the number of graduates of other types of colleges is many times greater than from the engineering colleges, these figures are even more striking, for they indicate that the probability of an engineering-trained man becoming president of an American industrial organization is 10 or 20 times as great as the same probability for a man of different college training. When we consider 54,000 officers of all types in finance, production, engineering and sales, we find an even stronger predominance of engineering-trained men, to such a extent that we can say that the probability of an engineering-trained graduate becoming an officer in an American industrial organization is from 25 to 50 times greater than this probability for a man of different college training.

These figures are a striking refutation of the wishful thinking back of the old saw, which goes, "You will always find the graduate of an engineering school working, but you will always find him working for some one else." Probably many of you have heard this statement with reference to the graduates of your own local institution.

By way of summary, therefore, of this whole survey of the American program for social progress, I think we can reduce the argument to two very simple and direct statements of fact. One is that the engineer, through the very nature of his experience and field of interest, has a most important position in bringing to accomplishment the various elements of this great program. A second is that experience shows that the engineering type of training is an unusually excellent training for responsible position in American industry.

With these statements of fact in mind, the conclusions as to our policy in regard to the rôle of engineers in this program for social progress are quite clear. Engineers should be given a more important rôle in the determination of national policies directed toward this program. They should be given the encouragement and stimulation which will lead to their best performance in achieving many of these objectives. Their environment, whether in government or industry or educational institution, should be made conducive to productive effort. And those of us who have a responsibility for engineering education in this country should take fresh courage from realization of the fundamental importance of our task and conviction that such contributions as we and our institutions can make are of such public value as to justify our best efforts.

OBITUARY

BOHUMIL SHIMEK

Professor Bohumil Shimek, member of the University of Iowa botany staff for the last 46 years, died at Iowa City, Iowa, on January 30, 1937, aged 75 years. His death was caused by heart complications following influenza. At the time of his death he was the second oldest member of the university staff. His name and work were inseparably linked with that of his noted naturalist colleagues, Thomas Huston Macbride, Charles C. Nutting and Samuel Calvin.

Professor Shimek was born in Shueyville, Iowa, on June 25, 1861, the son of Maria Theresa and Francis Joseph Shimek, political refugees who had immigrated to America from Bohemia in 1848. Professor Shimek's youth and education were closely bound up with the University of Iowa, which he entered in 1878 as a student of engineering. After attaining the C.E. degree, Professor Shimek was a railroad and county surveyor for two years. This early training and experience as an engineer resulted in unusual precision and exactitude in his later work in biology. In 1888 he accepted an instructorship in zoology at the University of Nebraska but returned to his alma mater in 1890 as a member of the botany staff. Professor Shimek's academic rise was rapid, as he soon became professor of botany, head of the department of botany, director of the Lakeside Laboratory, curator of the herbarium and later research professor. The high esteem in which Professor Shimek was held personally and as an educator was attested by the testimonial celebration tendered him by the university and the state of Iowa at the time of his retirement in 1932, at which time he had completed a fifty-year teaching career. The university in publishing his biography recognized his outstanding services as a pioneer, engineer, geologist, zoologist, conservationist, educator, patriot and citizen.

The chronicle of his life is unique both in the annals of the university and in the realm of natural science. Professor Shimek as a zoologist found his chief interest in the study of snails, and from his original interest along these lines developed his well-known work on fossil forms for which he has long been recognized throughout the world. His study of fossil malacology gradually developed into a broad interest in the Pleistocene geology of Iowa. He published a number of papers on loess and its fossils, and he is the author of the term "Nebraskan" applied to the till sheet which underlies the Aftonian interglacial deposits. Many of Professor Shimek's highest honors came in recognition of his geological work. He was a member of the Iowa State Geological Board and in 1911 was chairman of the Geological Section and vice-president of the American Association for the Advancement of Science, and in 1914 he was made honorary chairman of the Geological Section of the International Scientific Congress held in Europe as a tribute to his important contributions. The Geological Society of America had awarded him a research grant in 1936.

Professor Shimek's botanical contributions were in the field of ecology in relation to prairies. He strongly championed the concept that prairies were definite associations of species with common tolerance of intense light and rapid evaporation and that their treelessness was attributable to the high summer temperatures and drying winds. His notes comprise over fifty years of meticulous, quantitative observations which have followed the transitions of Iowa and surrounding prairies from pioneer times to the year of his death. He was at work in his office a few days before his final illness overtook him, studying herbarium material and completing a report on the plant geography of Iowa. Few scholars were as able as Professor Shimek to knit together vividly and accurately the whole story of natural history. His was a life spent largely out-of-doors in direct contact with the things about which he wrote. He was known for his insistence upon study in the field and the synthesis of the entire natural environment. In 1901 Professor Shimek took his first class of students to Lake Okoboji, where in 1909 the Lakeside Laboratory was established.

Professor Shimek labored ardently in behalf of the independence of Czechoslovakia in 1918, and with his personal friend, Thomas G. Masaryk, the historian, he planned during the latter's exile in America much of the strategy which finally resulted in Czech independence and Masaryk's election as the first president of Czechoslovakia. As president of the Czechoslovakian Council of Higher Education from its very inception he contributed greatly to the establishment of American standards and ideals of higher learning in the now independent nation of his forbears. He was called to the Charles University of Prague, Bohemia, as exchange professor in botany in 1914 and was awarded the Ph.D. degree in recognition of his scientific contributions. In recognition of his patriotic services he was awarded a special Czech medal of honor in 1927. His services to the state and education were memorialized by the Iowa legislature in a unanimous resolution of tribute passed on February 1, 1937.

Professor Shimek was long a leader in the educational development of the Middle West. He served as a member of several school boards and other education organizations. He was president of the Iowa Academy of Science in 1904 and later president of the Iowa Society of Engineers. He was a member of the

Botanical Society of America, Ecological Society, Washington and Iowa Academies of Science, Sigma Xi, national and state president of the Izaak Walton League, fellow of the American Association for the Advancement of Science, Geological Society of America, Botanical Society of Bohemia and Natural History Society of Prague. His passing is an irretrievable academic and civic loss to the state. He was the last of the elder statesmen of natural history in the Middle West.

W. F. Loehwing

WESLEY M. COATES

The sudden death of Dr. Wesley M. Coates has greatly shocked his colleagues in the department of physics of Columbia University and the Crocker Institute. Dr. Coates's death was due to an accidental contact with the power lines of the million-volt x-ray machine at the Presbyterian Hospital. The x-ray machine was not running at the time, but certain adjustments were being made on the oscillators which feed the x-ray apparatus preparatory to its use on the following day, and the presumption is that Dr. Coates slipped and accidentally came in contact with a power circuit of about 5,000 volts. His death was presumably instantaneous, for, despite every effort by his colleague, Dr. Exner, and the staff of the Presbyterian Hospital, he could not be revived.

He had received his academic training under Professor E. O. Lawrence and David H. Sloan at the University of California and a doctorate in physics in addition. He then worked with Professor Bergen Davis in the department of physics at Columbia University for two years, and for the past year has been active with Dr. Frank M. Exner, of the Crocker Institute, in putting the finishing touches on the x-ray machine belonging to the Crocker Institute, but housed by the Presbyterian Hospital. He and Dr. Exner and Professor Charles Packard had under way a large series of experiments in the field of biophysics. Dr. Coates was a man of excellent training, had a mind of very original type, and was an enthusiastic worker. He will be greatly missed by those with whom he worked.

F. C. W.

RECENT DEATHS

Dr. George H. Sherwood, curator-in-chief of education and honorary director of the American Museum of Natural History, New York City, died suddenly on March 19 at the age of sixty-one years.

Dr. James B. Overton, professor of plant physiology at the University of Wisconsin, died suddenly on March 18. He was sixty-seven years old.

Dr. Raymond R. Hitchcock, since 1914 head of the department of mathematics of the University of North Dakota, died on March 10. He was fifty-six years old.

Robert Walpole Ellis, professor of geology at the University of New Mexico for nineteen years and state geologist of New Mexico from 1918 to 1927, died on March 10 at the age of sixty-eight years.

Dr. Louis Beaufort, for thirty years professor of surveying and geodesy at the University of Toronto until his retirement in 1931 with the title emeritus, died on March 17 at the age of seventy-six years.

Dr. John F. Mackey, director of industrial work in the department of chemistry at the Central Technical School, Toronto, died on March 11 at the age of fifty-one years.

SCIENTIFIC EVENTS

THE FIELD MUSEUM OF NATURAL HISTORY

For the tenth successive time, annual attendance at the Field Museum of Natural History in 1936 exceeded one million visitors. The total number of visitors in the year was approximately 1,180,000. More than 94 per cent. were admitted free. Only about 67,000, or less than 6 per cent., paid the 25-cent admission charge required on certain days. Admission is free to the general public on Thursdays, Saturdays and Sundays; children, students, teachers and members of the museum are admitted free on all days.

During the school year, Chicago's 500,000 school children were kept in daily contact with the museum by means of some 1,300 traveling natural history exhibits which are circulated among the schools on regular schedule by the N. W. Harris Public School Extension department of the museum.

In the spring and autumn the annual courses of free illustrated lectures for adults were presented in the James Simpson Theater of the museum. These, and the series of free motion-picture programs for children, extension lectures in the schools, guide-lecture tours at the museum and other activities carried on by the division of the museum known as the James Nelson and Anna Louise Raymond Foundation, reached approximately 250,000 persons.

Exhibits in all departments were augmented by new installations. In the department of zoology is a new habitat group of the rare emperor penguins, for which specimens collected by Rear-Admiral Richard E. Byrd on his last expedition to the Antarctic were presented to the museum by the Chicago Zoological Society. Another new group shows the grotesque gelada baboons found only in Ethiopia. Of interest is an exhibit of six different species of penguins from various parts of the world, the rare tamarao buffalo found only in the island of Mindoro in the Philippines, a specimen of

Derby's guan, a strange bird obtained in Guatemala by an expedition led by Leon Mandel, and examples of the little known four-horned antelope of India and the seldom seen Ethiopian ibex. Additions to the department of botany include a miniature model of a tea plantation of Ceylon and eight large mural paintings, by Staff Artist Charles A. Corwin, of landscapes in which are seen exotic trees and plants. The department of geology added to its exhibits the world's only mounted skeletons of the prehistoric Titanoides, and of the South American fossil mammal Homalodothorium; a group of various prehistoric animals trapped in the Rancho La Brea "Tar Pools" near Los Angeles and a cut-away model of the earth illustrating its internal structure in accordance with accepted scientific theories. Additions and improvements were made also in various exhibits of the department of anthropology.

As for several years past, financial conditions prevented the carrying out of expeditions, which were formerly such a large item in the museum's activities. However, through the interest of various individuals, the museum was enabled to acquire some material from field work.

EXHIBIT OF SCIENTIFIC PHOTOGRAPHY

IN Rochester from March 15 to April 3 there is being held what it is planned to be the most comprehensive and the largest exhibition of technological photography hitherto assembled.

It emphasizes photography in which pictorial or artistic quality is not the prime consideration and which is intended to convey information rather than emotional gratification or amusement. In addition the exhibition includes the largest collection of color photography ever shown publicly in the United States.

The exhibition has been arranged by the Rochester Technical Section of the Photographic Society of America. It is entitled the first International Exhibit of Scientific and Applied Photography. It will be on view in Rochester, where it is assembled, for three weeks; then it will move to certain large cities including New York, Chicago, Philadelphia, Kansas City and the West Coast. There will be no prize awards. There is no intention to advertise any particular make of photographic goods.

Over 1,500 photographs have already been received from the United States and many European countries. In addition to these the exhibition will include a group of 300 prints, collected for it by the Royal Photographic Society of England.

The emphasis is on scientific photography. The largest single section is that on medical photography. Another large and complete section is that on photomicrography.

Below are enumerated some of the exhibits to be shown:

The moon photographed on a glass sphere coated with emulsion.
Water spouts.
Aurora borealis photographs from the University of Oslo.
The very rarely seen anti-crepuscular rays.
Photographs, taken from 14½ miles' altitude, showing actual curvature of the earth.
Complete history of the 1937 flood by the United States Army Air Corps.
Motions never seen by human eye taken at 1,000 pictures per second—including analysis of explosions in gasoline engines.
News pictures transmitted by various electrical means.
Fish building nests under water.
The life histories of the black widow spider and the malaria-carrying mosquito.
First photograph of the positron.
Plates carried to 20 miles' altitude in sounding balloons to record cosmic ray tracks.
Industrial x-ray photography.
Entire volumes of books photographed on short strips of motion picture film.
Photographs on gelatine sheets as were carried out of Paris by carrier pigeons during War of 1870.
Photomicrographs taken by streams of electrons rather than light rays, yielding magnifications of 6,600 times.
The highest magnification ever achieved showing resolution of lines one five-hundred-thousandth of an inch apart.
Time resolution of events occurring one ten-millionth of a second apart.
Color photographs of operations on the human brain.
Plastic surgery studies.
Facial studies of dementia praecox patients.
The arterial system of a human fetus.
The prenatal development of a rabbit from the one-celled stage to birth.
Amputations of arms and legs.
Recent cancer research.
Gallstone operation.
The interior of normal and abnormal human hearts and human eyes.
Moth larvae engaged in eating a woolen blanket.
The eggs of butterflies.
An original Daguerre camera, with daguerreotypes of famous personalities of a century ago.

THE WILDLIFE SOCIETY

FOLLOWING a year of existence as the Society of Wildlife Specialists, formal organization of the Wildlife Society was accomplished at a meeting at St. Louis, Mo., from February 27 to March 2. The society is primarily a professional group in which active members shall be those engaged in the practice of teaching of wildlife research, management or administration, or who are graduate students of those subjects. Associate members shall be those interested in the objects of the society who are sponsored by two active members. Some of the principal objectives of the Wildlife Society are the development of all types of wildlife man-

agement along sound biological lines, the establishment of professional solidarity among conservation biologists and the maintenance of the highest possible professional standards.

An official organ, *The Journal of Wildlife Management*, to contribute to these ends, will be launched in 1937, probably as a quarterly, under the editorship of W. L. McAtee, U. S. Biological Survey, Washington, D. C.

The governing body of the society for the year 1937, consisting of the officers and six regionally representative councilors, includes:

President, Rudolf Bennitt, associate professor of zoology, University of Missouri, Columbia, Mo.
Vice-president, Joseph S. Dixon, field naturalist, National Park Service, San Francisco, Calif.
Secretary, Victor H. Cahalane, assistant chief, Wildlife Division, National Park Service, Washington, D. C.
Treasurer, Warren W. Chase, regional biologist, Soil Conservation Service, Des Moines, Iowa.

Councilors:

For Region 1 (Northeast), Arthur A. Allen, professor of ornithology, Cornell University, Ithaca, N. Y.
For Region 2 (Southeast), William J. Howard, regional wildlife technician, National Park Service, Richmond, Va.
For Region 3 (North Central), Samuel A. Graham, professor of economic zoology, University of Michigan, Ann Arbor, Mich.
For Region 4 (Northern Great Plains), Verne E. Davison, regional biologist, Soil Conservation Service, Rapid City, S. Dak.
For Region 5 (Southwest) Walter P. Taylor, senior biologist, Bureau of Biological Survey, Texas A. and M. College, College Station, Texas.
For Region 6 (West), E. Lowell Sumner, Jr., regional wildlife technician, National Park Service, San Francisco, Calif.

The following advisory committee also has been named by the president:

Aldo Leopold, University of Wisconsin, Madison, Wis.
Herbert L. Stoddard, Thomasville, Ga.
Joseph Grinnell, University of California, Berkeley, Calif.
Ralph T. King, University of Minnesota, St. Paul, Minn. (past president).

THE VICE-PRESIDENT OF THE UNIVERSITY OF CALIFORNIA AT LOS ANGELES

DR. EARLE RAYMOND HEDRICK, professor of mathematics, was named vice-president and provost of the University of California at Los Angeles at a special meeting of the regents on March 10. The appointment was made on the recommendation of President Robert G. Sproul, the faculty at Los Angeles, the regents' committee of the University of California at Los Angeles and the Scripps Institution of Oceanography. The action of the regents was unanimous. Dr. Hedrick fills the vacancy caused by the retirement from administrative work on July 1 of Dr. Ernest Carroll Moore, now professor of education and philosophy at Los Angeles.

Dr. Hedrick was formally installed at the Charter Day exercises held on the Los Angeles campus on March 19. President Sproul presided at this meeting and made the formal installation. Dr. Hedrick delivered the annual Charter Day address in observance of the sixty-ninth anniversary of the founding of the University of California. He also spoke at the annual Charter Day dinner on March 23.

Dr. Hedrick, then of the University of Missouri, went to Los Angeles in 1924 as professor of mathematics and chairman of the department of mathematics. He was born at Union City, Indiana, on September 27, 1876. He received the degree of bachelor of arts from the University of Michigan in 1896, of master of arts from Harvard University in 1898 and of doctor of philosophy from the University of Göttingen in 1901. He was also a student at Ecole Normale Supérieure, Paris. The honorary degree of doctor of science was conferred on him by the University of Michigan in 1936.

Dr. Hedrick is a former president of the American Mathematical Society and of the Mathematical Association of America; he is a former vice-president of the American Association for the Advancement of Science, and is now secretary of the section of mathematics; he is a member of the American Society of Mechanical Engineers, of the American Institute of Electrical Engineers, of the Society for the Promotion of Engineering Education, of the National Education Association, of the Circolo Matematico di Palermo, Italy, and of the Société mathématique de France. He is also a member of the Council of Northern California Alumni of Phi Beta Kappa and of Sigma Xi.

Dr. Hedrick is a member of the American Engineering Standards Committee since 1927; a member of the Committee of the United Engineering Societies on Notation, and is chairman of the American Section of the International Commission on the Teaching of Mathematics. He has been editor of the *Bulletin* of the American Mathematical Society since 1921.

SCIENTIFIC NOTES AND NEWS

ON the occasion of the International Symposium on Early Man, in celebration of the one hundred and twenty-fifth anniversary of the founding of the Academy of Natural Sciences of Philadelphia, the degree of doctor of science was conferred by the University of Pennsylvania on Dorothy Annie Elizabeth Garrod, of

Newnham College, Cambridge, director of the joint expedition of the British School of Archeology in Jerusalem and the American School of Prehistoric Research; on Dr. Vere Gordon Childe, professor of prehistoric archeology at the University of Edinburgh, and on Dr. Kaj Birket-Smith, director of the National Museum in Copenhagen.

THE Vega Gold Medal of the Royal Swedish Geographical Society has been awarded to Dr. Roy Chapman Andrews, director of the American Museum of Natural History, in recognition of his contributions to geographical and anthropological science. The formal presentation will be made on April 24, when the medal and the accompanying certificate will be given by Crown Prince Gustav Adolf of Sweden to Laurence A. Steinhardt, American minister to Sweden.

THE Hillebrand Prize for 1936 has been awarded by the Chemical Society of Washington to Dr. Vincent du Vigneaud, professor of biochemistry at the George Washington University Medical School. The award, which was presented to him on March 11, was made in recognition of his contributions to the chemistry of the biologically significant sulfur compounds and particularly for a paper on the synthesis of glutathione which was presented before the Chemical Society of Washington last October.

THE rank of Chevalier of the Legion of Honor has been conferred by the French Government on Dr. J. B. S. Haldane, professor of genetics at University College, London, in recognition of his scientific services to France.

TENNEY L. DAVIS, associate professor of organic chemistry at the Massachusetts Institute of Technology, has been elected a corresponding member of the Royal Society of Letters and Sciences of Bohemia.

AT a commemorative dinner held on March 12, Professor Albert Johannsen was honored by the department of geology of the University of Chicago on the occasion of his retirement from teaching. A portrait, the gift of Kappa Epsilon Pi, graduate geological fraternity, was unveiled, and Dr. Johannsen was presented with a bound volume of letters from former students and colleagues. Plans were also announced for issuing a special supplement to *The Journal of Geology,* in commemoration of the event. Professor Edson S. Bastin, chairman of the department of geology, presided at the dinner, and Professor R. T. Chamberlin delivered an informal commemorative address.

HORACE M. ALBRIGHT, formerly director of the National Park Service, has been elected president of the American Planning and Civic Association, which is active in the federal program of land and water conservation and development.

DR. CHARLES ROOT TURNER, dean of the Dental School of the University of Pennsylvania, was named president-elect of the American Association of Dental Schools at the recent convention in Baltimore.

THE following officers of the Royal Meteorological Society, London, have been elected: *President,* Dr. F. J. W. Whipple; *Treasurer,* W. M. Witchell; *Secretaries,* H. W. L. Absalom, W. Dunbar and E. L. Hawke; *Foreign Secretary,* J. F. Shipley; *New Members of Council,* Miss Ellen E. Austin and R. S. Read.

DR. LEWIS R. THOMPSON, assistant surgeon general, U. S. Public Health Service, has been made director of the National Institute of Health. From 1932 to 1934 he was a scientific director of the International Health Division of the Rockefeller Foundation and is now in charge of the division of scientific research of the Public Health Service.

DR. CHARLES MANNING CHILD, professor of zoology at the University of Chicago, has resigned after serving as a member of the faculty for forty-two years. Professor Child plans to live in Palo Alto and to continue his research work in the marine laboratories of Stanford University.

PROFESSOR LEE EDWARD TRAVIS has been appointed head of the department of psychology at the State University of Iowa to succeed Dean-Emeritus Carl E. Seashore on July 1. Professor Seashore will continue as research professor.

AT Columbia University, Professor Franz Schrader has been named head of the department of zoology, and Professor Joseph F. Ritt has become acting head of the department of mathematics.

DR. A. R. DAVIS, professor of plant physiology, has been named chairman of the department of botany of the University of California.

DR. ARTHUR G. NORMAN, of the Rothamsted Experimental Station, Harpenden, England, has been appointed professor of soil bacteriology in the department of agronomy of the Iowa State College and research professor of soil bacteriology in the Agricultural Experiment Station. Dr. Norman will go to Ames in September, filling the position formerly held by Dr. R. H. Walker.

DR. DANIEL J. POSIN, instructor in physics in the College of Pharmacy at the University of California, has accepted appointment as professor of physics at the University of Panama. He will sail for Panama in April.

DR. EDGAR DOUGLAS ADRIAN, fellow of Trinity College, has been elected to succeed Professor Sir Joseph Barcroft, fellow of King's College, in the chair of physiology at the University of Cambridge.

Dr. James Gray, fellow of King's College and reader in experimental zoology in the University of Cambridge, has been elected to the professorship of zoology in succession to Professor J. Stanley Gardiner, fellow of Gonville and Caius College, who retires at the end of September, having occupied the chair of zoology since 1909.

Dr. Herbert Lightfoot Eason, vice-chancellor of the University of London, was appointed on March 17 principal of the university, to succeed the late Sir Edwin Deller, who had held the position since 1929. Dr. Eason was superintendent and senior ophthalmic surgeon of Guy's Hospital and is a former dean of the medical school.

M. Frédéric Joliot has been appointed professor of chemistry in the Collège de France.

Francis Heming, of the British Museum (Natural History), has been appointed secretary of the International Commission on Zoological Nomenclature. He succeeds Dr. Ch. Wardell Stiles, who has been secretary of the commission since 1896.

Dr. Jesse E. Hunter, associate professor in charge of poultry nutrition in the department of agricultural and biological chemistry at the Pennsylvania State College, has resigned to accept a position with Allied Mills, Inc., at Peoria, Ill.

M. Ch. Maurin has been named the successor of the late M. Hamy as member of the Bureau of Longitude, Paris.

Stephen L. Tyler, for more than twenty years chemical engineer in the American branch of the Thermal Syndicate, Ltd., has been made executive secretary of the American Institute of Chemical Engineers, effective on April 1. He will fill the unexpired term of Frederic J. LeMaistre, who recently resigned. The office of the institute will be moved from Philadelphia to New York.

Dr. Stillman Wright, limnologist of the Fish Commission of northeast Brazil, has returned from a three months' leave of absence in Argentina, where he made a preliminary survey of some lakes for the government. He will continue work on the artificial lakes of northeast Brazil, making his headquarters in Fortaleza, Ceara.

Dr. Isaiah Bowman, president of the Johns Hopkins University, will deliver the Founder's Day address at the University of Virginia on April 13, the anniversary of the birth of Thomas Jefferson.

Dr. J. B. Sumner, of Cornell University, addressed a joint meeting of the Toronto Chemical Association and the Toronto Biochemical Society on the evening of March 18. His subject was "The Enzyme Urease."

Dr. Valy Menkin, of the department of pathology of the Harvard Medical School, addressed the New York Pathological Society on February 25 on "Mechanisms of Inflammation."

Dr. George H. Parker, professor emeritus at Harvard University, gave the Mead-Swing Lecture at Oberlin College on March 12. His subject was "The Nature and Action of Neurohumors."

Sir Henry Dale, director of the British National Institute for Medical Research, on May 18 will address the Academy of Medicine of Washington, D. C. He will speak on the chemical transmission of the nerve impulse from nerve to muscle.

The American Association of Museums will meet at New Orleans on May 3, 4 and 5.

The fifth annual meeting of the Society for Research on Meteorites will be held in conjunction with the one hundredth convention of the American Association for the Advancement of Science and its western Divisions at Denver, Colorado, on June 22 and 23. There will be two sessions a day, mainly for papers, one in the morning at ten o'clock and another in the afternoon at two o'clock. These sessions, which will be open to the public, will be held in the Colorado Museum of Natural History, the headquarters for the meeting.

Applications for grants from the Cyrus M. Warren Fund of the American Academy of Arts and Sciences should be received by the chairman of the committee, Professor James F. Norris, the Massachusetts Institute of Technology, Cambridge, Mass., not later than May 1. Grants are made to assist research in the field of chemistry. On account of limited resources, grants to an individual are seldom made in excess of $300. The application should be accompanied by an account of the research to be undertaken, a statement of the sum requested and the manner in which the money is to be expended.

A special summer school with conferences on the strength of materials will be held at the Massachusetts Institute of Technology for four weeks beginning on June 21. The subject of "Creep" will be presented by Dr. A. Nadai, consulting engineer of the Westinghouse Electric and Manufacturing Company, East Pittsburgh, the last two lectures of this series being given by C. R. Soderberg, manager of the steam turbine department, Westinghouse Electric and Manufacturing Company. Lectures on fatigue will be given by Dr. H. J. Gouch, superintendent of the department of engineering of the National Physical Laboratory, England. Lectures on the strength of materials will be given by members of the institute staff. The laboratory exercises in the testing of metals will make

use of the more modern measuring instruments and apparatus. Four seminars will be held to afford opportunity for the presentation of recent developments in allied fields of engineering mechanics. The course will be concluded by two all-day conferences on "Fatigue and Creep," at which various aspects of these two subjects will be discussed.

ONE fourteenth of the total population of the United States, or 9,929,432 people, visited the 134 national parks and monuments in 1936, a gain of more than four million over 1935, and a gain of more than six million over the depression year 1931, when only 3,619,900 persons visited the areas. 1,772,338 people visited the parks in private cars during 1936 as against 1,217,054 in 1935. The newly established Shenandoah National Park, Virginia, dedicated on July 3, 1936, was visited by nearly 700,000 people; the Great Smoky Mountains National Park, on the border of North Carolina and Tennessee, by 602,222; Acadia National Park, Maine, by 340,393, and Mammoth Cave National Park, Kentucky, by 57,775. In the West, Rocky Mountain National Park, Colorado, reports 550,496 visitors; Yellowstone National Park, Wyoming, 432,570; Yosemite National Park, California, 431,192; Mount McKinley National Park, Alaska, 1,073.

A 2,200 acre wildlife refuge will be established by the U. S. Biological Survey in the Patuxent River valley section of Maryland. It has been named the Patuxent Research Refuge. The refuge, part of the National Agricultural Research Center of the Department of Agriculture at Beltsville, is about fifteen miles northeast of Washington. Wild turkeys, ruffed grouse, white-tailed deer, beavers, muskrat and other wildlife, once abundant in this section, are to be restocked on the refuge. Certain areas of the refuge will also be set apart for demonstrating wildlife management practices. On these tracts the Biological Survey will show how the latest facts found through research and experiment can be applied. Snowden Hall, an old-time southern mansion, is located on the refuge. It is to be reconditioned for the refuge headquarters, and other necessary buildings will be provided. A new laboratory building will be one story and basement. It will contain an office, three biological laboratory rooms, a room for housing wild birds and animals infected with disease, another for healthy animals and birds, and rooms for examining and storing specimens.

A PLAN to establish Pan-American postgraduate schools and hospitals in all the large cities of Central and South America was discussed recently, at a meeting of physicians at the Metropolitan Club, New York City, by Professor José Arcé, dean of the University of Buenos Aires. Professor Arcé, who is president of the Argentine Chapter of the Pan-American Medical Association, was the guest of honor at a dinner of the New York Chapter of the association. Speakers for the United States were Dr. Charles Gordon Heyd, president of the American Medical Association; Dr. James Ewing, of Memorial Hospital, and Dr. Dean Lewis, of the Johns Hopkins University. The plan announced by Professor Arcé is for the establishment throughout the republics of Central and South America of medical centers similar to the one proposed recently for New York City.

DISCUSSION

THE "PRIMARY CHANGE" IN ADRENAL INSUFFICIENCY[1]

IN his communication to SCIENCE entitled "The Significance of the Adrenals for Adaptation," Selye[2] makes the following statement. "It seems quite likely that the loss of sodium which is the basic change according to those who believe in the sodium deficiency theory (Loeb, *et al.*) or the increase in potassium (Zwemer) . . . all of which have been considered to be the primary change—are also symptoms rather than the cause of adrenal insufficiency." We have consistently avoided any expression which would suggest that we believe in a "sodium deficiency theory" or any other theory assigning a single function to the adrenal cortex. Furthermore, it is our opinion that the promulgation of any unitarian hypothesis concerning the function of the adrenal cortex tends, at this time, to inhibit the advance of physiological knowledge in this field.

It is indisputable that the regulatory effect of the adrenal cortex upon sodium metabolism is *one* of its important functions. The very fact that the single procedure of sodium withdrawal will induce acute adrenal insufficiency in the Addisonian patient[3] and the adrenalectomized dog is of obvious significance. Moreover, Harrop[4] has shown that totally adrenalectomized dogs will live for months without cortical extract if sodium salts are ingested in sufficient quantities.

On the other hand, we wish, in view of Selye's statement, to emphasize here, as we have in other publications, that the physiological activities of the adrenal cortex are varied and complex. In 1934,[5] we stated

[1] From the Department of Medicine, College of Physicians and Surgeons, Columbia University, and the Presbyterian Hospital, New York City.

[2] H. Selye, SCIENCE, 85: 247, 1937.

[3] R. F. Loeb, *Proc. Soc. Exp. Biol. Med.*, 30: 808, 1933.

[4] G. A. Harrop, L. J. Soffer, W. M. Nicholson and M. Strauss, *Jour. Exp. Med.*, 61: 839, 1935.

[5] R. F. Loeb and D. W. Atchley, *Med. Clin. of North America*, Vol. 17, New York Number, No. 5, 1317, 1934.

t "it should be emphasized that we do not assume t the regulation of salt balance is the sole function the adrenal cortex." Furthermore, we have pointed t[6] that the adynamia, hypotension, hypoglycemia, gmentation, gastro-intestinal symptoms and neuro-gical disturbances of Addison's disease may occur thout a decrease in sodium, and finally,[7] that trength increases strikingly in the adrenalectomized g following the administration of cortical extract fore obvious changes occur in the blood urea or dium concentration or in the water content of the ood serum."

ROBERT F. LOEB
DANA W. ATCHLEY

IGRATION" AND "HOMING" OF SALMON

BY derivation "migration" signifies "wandering." has come to mean, especially in biology, a definite, rposive movement, preferably "en masse." The lmon is an outstanding example of the fishes that e supposed to show such movements. The Atlantic lmon (*Salmo salar*) spends a number of years as a arr in its natal river before transformation into the olt stage. The latter is considered to make a feed-g migration to the ocean and after several years hen an adult a spawning migration back to its natal ver. For their return "from the ocean" perhaps to points far distant from their own rivers" and for eir subsequent "travel along the coast" Calderwood[1] tates "they find their way by a homing instinct which an can not comprehend."

On inquiry and examination of the literature I have iled to find a single clear case of a salmon returning o its natal river from a distant place in the sea, that , away from the neighborhood of the river mouth. dmittedly this is a difficult thing to prove, since we ust be sure of three things for the individual fish: 1) Which is its natal river? (2) where it has been in he sea, and (3) that it is again in its river. Perhaps ome one may be able to produce such evidence. With-ut it, however, it seems pointless to speak of a "hom-ng instinct."

The movements that have been definitely shown may e placed in three categories: (1) Fish marked as smolts r tagged as kelts in a certain river, being recaptured n that river after having left it, but not necessarily aving gone from the neighborhood of the river mouth; 2) fish marked as smolts or tagged as kelts in a certain iver being recaptured at a near or distant place in the ea or in another river; and (3) fish tagged in the sea nd recaptured at another place in the sea or in a river. There may be mentioned for the Atlantic salmon Alm's[3] experiments in the Baltic, Dahl and Sømme's[4] for the Norwegian coast, those of Calderwood[5] and others for Scottish waters as well as the Canadian ones.[2, 6] There have been similar experiments with the Pacific salmons.[7]

In quite a number of instances salmon marked or tagged in one river have been recaptured in another, which constitutes definite evidence against homing. White[2] has shown that this may occur even when the fish is presented at a fork in a common estuary with a choice between another river and its own.

If the traditional conception of salmon migration falls to the ground for lack of definite proof and with clear evidence to the contrary, what is to replace it? The facts show that the salmon wanders to and fro in the sea and this may be considered a migration. Such slight evidence as we have and the analogy of the herring point to these excursions being made when the fish is not feeding. Their range seems to increase with the size of the fish[8] and also, it may be confidently affirmed, with rise in temperature from the winter low, which may be less than 0° C. When the salmon are within the zone of the river's influence at sea these excursions seem to be definitely controlled by a sufficiently steep gradient in the proportion of river water, so that the salmon tend to remain where the proportion is high, as shown by the distribution of the salmon in relation to the outflow of Saint John River water into the Bay of Fundy.[8] The Scottish River Tay similarly has a pronounced zone of influence at sea,[5] and the two rivers agree in that none of the salmon kelts tagged and liberated in them has ever been reported as recaptured in the sea outside the zone of influence or in another river.

It would seem that if a fish happens to get very far from this zone of river influence there is little likelihood that it will in its random wanderings reach the place where the marked gradient occurs. It may then be said to be "lost." Such salmon may reach neighboring rivers or travel very far in the sea. Though they wander to and fro, yet is their course in part determined by the movement of the water. As they tend to keep near the surface, it is not surprising to find that

[6] R. F. Loeb, *Jour. Am. Med. Assn.*, 104: 2177, 1935.
[7] J. Stahl, D. W. Atchley and R. F. Loeb, *Jour. Clin. Invest.*, 15: 41, 1936.

[1] W. L. Calderwood, "A Survey of Salmon Fisheries in Eastern Canada," p. 4, 1930.
[2] H. C. White, *Jour. Biol. Bd. Can.*, 2: 391–400, 1936.
[3] Gunnar Alm, *Ny Svensk Fiskeritidskrift*, 1: 1–6, 1931.
[4] K. Dahl and S. Sømme, *Skr. Norsk. Vid.-Ak. Oslo, I. Mat.-Nat.* Kl., 1935, No. 12.
[5] W. L. Calderwood, "The Life of the Salmon," 1908.
[6] A. G. Huntsman, *Bull. Biol. Bd. Can.* 21: 78–92, 1931.
[7] W. H. Rich and H. B. Holmes, *Bull. U. S. Bur. Fisheries*, 44: 215–264, 1928; J. O. Snyder, *Calif. Fish Bull.*, 34: 67–81, 1931; "Pacific Salmon Migration," various articles by H. C. Williamson, C. McC. Mottley and others in *Contr. Canad. Biol. Fish.*: 3 and 4, and in *Bull. Biol. Bd. Can.*, 14, 15, 16, 26, 27, 31, 40, 41.
[8] A. G. Huntsman, *Bull. Biol. Bd. Can.*, 51: 14–15, 1936.
[9] Ann. Rep. Dept. Fisheries Can., 4, 5 and 6: 113, 130 and 130–131, 1934, 1935 and 1936.

to a considerable extent they go where drift bottles go. In Canadian Atlantic waters drift bottles mostly travel to the northeast in correspondence with the prevailing southwest winds of summer. From 1931 to 1934, 642 salmon kelts were tagged and liberated in the Nictaux River, a branch of the Annapolis River of western Nova Scotia. This river has a very weak influence where it empties through the Annapolis Basin and Digby Gut into the Bay of Fundy. Of the 24 salmon recaptured and reported,[9] five were taken at various points on the east coast of Newfoundland, a minimum distance by sea of about 900 miles and one at Ramah in northern Labrador, more than 1,000 miles farther and northward along the coast. The remainder were all taken in the river, except one at Yarmouth, N. S., which is on the route to Newfoundland. The drift bottles that take this course northeastward from the mouth of the Gulf of Maine have been found only as far as Sable Island on this side of the Atlantic. Most of them enter the North Atlantic drift, which carries them to the Azores and the European coast. The salmon, on the other hand, seem to keep to the waters with river ingredients, which extend little beyond the banks, and thus they ultimately reach some point on the coast.

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A WHALE SHARK IMPALED ON THE BOW OF A STEAMER NEAR THE TUAMOTUS, SOUTH SEAS

THROUGH the courtesy of Rear Admiral W. R. Gherardi, head of the Hydrographic Office of the U. S. Navy, I have learned of the interesting happening indicated in the title of this note. Through his kindness there was published in *Hydrographic Bulletin* No. 2362 a short description and a good figure of the whale shark (*Rhineodon typus*). This was done in the hope that the interest and help of ships' officers might be enlisted for the sending in of observations of the occurrence of this greatest of sharks. This hope has been abundantly realized. Information concerning the particular specimen in question comes from Mr. S. H. Crawford, third officer of R. M. S. *Maunganui* of the Union Steam Ship Company of New Zealand, Ltd.

On September 7, 1934, in Lat. 13° 59′ S. and Long. 147° 46′ W. (about 60 mi. N. N. E. of Tikehau Atoll in the Tuamotus) the *Maunganui* struck a large animal at first thought to be a whale. The vessel was steaming at about 16 knots and the animal was struck so sharply just behind the head that it was impaled on the stem of the ship. Here it was held so securely by the pressure of the water that the engines had to be reversed and the ship backed before the bows could be cleared of the great carcass.

While on the bow of the steamer, the head-to-gi region was estimated at about 15 feet and the remai der of the body at about 40 feet, making the to length about 55 feet. This could well have been, f in the Indian Ocean the fish has been measured to feet, and in the Gulf of Siam estimated by an ichthy logical friend of mine at 60 feet.

Recalling the figure of *Rhineodon* seen in the *Hydr graphic Bulletin*, when Mr. Crawford noted the squar cut head and the speckled markings plainly visibl he recorded the fish as a whale shark. A photogra was taken of the fish held against the vessel's ste and a copy of this through the good help of the Hydr graphic Office was obtained from Captain Tot This settled the matter once and for all that a secon whale shark must be recorded from the Tuamot Archipelago, South Seas.

In May, 1928, divers at work in Takeroa lago were confronted by a spotted shark about 17 feet lon They killed and skinned it. M. F. Hervé, admini trator of the Tuamotus, sent the skin to the litt museum at Papeete, Tahiti. M. Rougier, curator o this museum, made record of it in *Bulletin Soci Études Océanographique*, Papeete, 1929, Vol. 3, 31 319.

It will interest the reader to know that this is t sixth recorded case of the spearing of a whale shar by a steamer making her way over the ocean. O case has been recorded from the Indian Ocean, tw from the Red Sea and two from the Atlantic. I pla later to bring these accounts into an article.

E. W. GUDGER

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OF NATURAL HISTORY

JELLYFISH FROM GRAND CANYON ALGONKIAN

THE impression of a medusa, commonly known a a jellyfish, was found during the summer of 1934 i a fine-grained sandstone of the Nankoweap group o the Grand Canyon series.[1] The Grand Canyon seri lies upon the Archean complex and has been divide into the Unkar, Nankoweap and Chuar groups. Th medusa measures 18 cm across and is thought to b a marine type. A paper giving the details of thi specimen is now in preparation.

The writer examined the lower portion of the Algon kian rocks during 1933 and 1934 under a progra sponsored by the Carnegie Institution of Washingto and was accompanied by R. A. Bramkamp when th medusa was found.

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[1] C. E. Van Gundy, Abs. Program Cordilleran Sectio Geol. Soc. of America, April, 1936.

REPORTS

ACTIVITIES OF THE ENGINEERING FOUNDATION

THE scientific laboratories of fourteen universities cooperating with the Engineering Foundation in effort to solve technological and human problems the fields of mechanical, electrical, mining and tallurgical and civil engineering, according to a ort by the foundation.

Two government bureaus are aiding in special inves-tions. Working with other groups, the four nder societies, of which the foundation is a re-rch agency, are advancing engineering education l professional development as well as personnel earch.

Long-term projects sponsored by the foundation lude alloys of iron research, comprising a review world information on alloy steels and alloy cast ns; and welding research, embracing more than ty fundamental studies in college and industrial oratories and a compilation of welding literature.

Cottonseed processing research is being carried on laboratory and field by a committee of the American ciety of Mechanical Engineers with headquarters the University of Tennessee.

World interest in earths and foundations has been oused by a committee of the American Society of vil Engineers, which has directed research in this here since 1929. A soil mechanics laboratory has en established at Harvard University. The lateral pporting power of soils to individual piles, anchors d bulkheads is being studied at Yale University. odels of earth dams and coffer-dams are furthering tensive investigations at the University of Min-sota.

Barodynamic research, the study of weighty masses means of special centrifuges, is going forward at e School of Mines of Columbia University. Con-mation of laboratory results has been obtained from rface and underground observations of mining prob-ns in Europe and Africa. A device for determining le pressures of loose materials and a new type of tificial support in mines have been developed. ress distribution in mine pillars and roofs and the me effect in rock structures strained beyond elastic nits have been determined.

Designs for a new type of critical pressure steam iler may grow out of a basic investigation at Purdue niversity by the Society of Mechanical Engineers. eterminations of viscosity of water and steam and actions between steam metal at elevated tempera-res have been studied particularly. At the Univer-y of Michigan, a boiler feed water research project concerned with methods of determining oxygen in e waters.

The Non-Metallic Minerals Experiment Station of the U. S. Bureau of Mines in New Brunswick, N. J., is attacking the problem of embrittlement in boiler steel and expects to learn its cause and means of prevention.

A specially built machine at the Massachusetts Institute of Technology is testing the strength of gear teeth. Recent operations have been devoted to experiments with surface fatigue of cast iron.

A large piece of steel known as a "test log" is being cut at the University of Michigan in the course of an investigation of the efficiency of cutting fluids, that is, the fluids used for lubricating and cooling metal-cutting tools. A handbook on "Cutting of Metals" has recently been completed under direction of the American Society of Mechanical Engineers.

The National Bureau of Standards, Massachusetts Institute of Technology, Cornell University, the Universities of California, Ohio, Oklahoma and several industries are conducting experiments with long-radius flow nozzles, used in fluid meters, in order to provide more economical and convenient means for precise measurements of large quantities of liquids or gases, as in efficiency tests of steam and hydraulic power installations. In some instances steam is used, in others, water, through nozzles ranging from three inches to sixteen inches in diameter and also through two-inch pipe orifices.

Ten years of research on pure iron electrodes, sponsored by the American Institute of Electrical Engineers at Lehigh University, was recently completed. This phase of welding research will be merged in the comprehensive program of the foundation's welding research committee.

Information on the creep and relaxation of metals was gathered last year as part of a study of metal plasticity carried on at the University of Pittsburgh, with research facilities provided by the Westinghouse Research Laboratories. Special apparatuses were designed and constructed for the work, the results of which are proving of practical value.

Nearly 500 specimens of concrete are under observation in long-time tests at the University of California to determine the various factors in the plastic behavior of concrete. Three new series of investigations have been started, comprising studies of the moisture loss accompanying plastic flow under sustained load, of the validity of the assumption of plane bending in beams under sustained load, and of the effect of compound composition and fineness of cement upon plastic flow. Thermal stress studies have already been completed.

Through the Personnel Research Foundation, the Engineering Foundation is encouraging forms of em-

ployer-employe cooperation by visits to industrial plants, correspondence with governmental departments and labor organizations and by conferences.

Six thousand copies of "Self-Appraisal for Junior Engineers" were placed in the hands of engineering students last year by the Engineers' Council for Professional Development, composed of representatives of the national engineering societies and professional organizations. Nearly 5,000 copies of a booklet on "Engineering—A Career—A Culture" were distributed during the year.

The council, conducting an investigation on the accrediting of schools, sponsored visits to schools in New England and the Middle Atlantic States. The wo is now being initiated in other states. The council also directing studies on the evaluation of professio qualifications, guidance literature and aptitude tes A selected reading list of books on general fields knowledge for young engineers and a bibliography technical literature have been prepared.

The council seeks uniformity in engineering degre Conferences are being arranged for boys interested engineering, their parents and local engineeri groups. A survey has been made of university exte sion facilities, and a manual on guidance for local se tions of the national engineering societies is availab

SPECIAL ARTICLES

THE NEW DISCOVERY OF THREE SKULLS OF SINANTHROPUS PEKINENSIS

FOLLOWING the recovery of several fragments of a very small adult of *Sinanthropus* from Locus I (Locality 1) in the latter part of our spring field season at Choukoutien, we had the good fortune during the fall season of this year to unearth three additional more or less well-preserved skulls, two of which were recovered in one day. All three skulls belong to adult individuals. The skull recovered first, and designated as Skull I of Locus L, is the largest with a cranial capacity of approximately 1,200 cc and with its coronal and sagittal sutures partly fused. The second skull (Skull II of Locus L) is the smallest of the group, with a cranial capacity not higher than 1,050 cc and its coronal, sagittal and lambdoid sutures fused. This skull shows a clear indication of the persistence of a metopic suture. The third skull (Skull III of Locus L) is smaller than Skull I but larger than Skull II. The cranial capacity of Skull III is approximately 1,100 cc. Although all the sutures of this skull are still patent, yet other characteristic features make it evident that we are dealing with a young adult individual. Parts of the face are preserved in all three skulls, thus, in Skull III both nasal bones and the entire lateral border of the orbit in complete connection with the brain case; in Skull II the frontal process of the maxilla, the lower border of the orbit, the cheekbone and fragments of the alveolar process of the upper jaw with palate and ten teeth *in situ* (premolars and molars) which, however, are not connected with the skull. Belonging to Skull I are several teeth only.

I had previously arrived at the conclusion that the large teeth may belong to male individuals and the small to female individuals. This assumption has been confirmed by the fact that the large type of teeth was found to pertain to the bigger skull (Skull I) and the small type of teeth to the small skull (Skull II). Thus it seems quite certain that the latter represents the skull of a female individual and the former that of a male individual.

All three skulls have the same appearance as Sku I of Locus E described by Davidson Black.[1] However, since this skull belongs to a child of about 8 t 9 years (*cf.* Weidenreich, 1935)[2] the characteristics o the *Sinanthropus* type are much more pronounced i the recently recovered skulls. Measurements reve that *Sinanthropus* as a whole occupies the lowest pla in the order of all hominids, including *Pithecanthropu* in regard to those peculiarities which determine i position in the line of evolution. This is particular true for Skull II of Locus L, while Skull I of Locus in part falls within the lower limits of the range o variations of the Neanderthal group. However, Sku II apparently is even lower than *Pithecanthropus*, t difference being that the *Sinanthropus* skull shows more pronounced frontal tuber than *Pithecanthropu* the entire forehead of which is flattened. The small ness and lowness of *Sinanthropus* Skull II is all th more remarkable since the skull fragments recovere last summer and considered to pertain to an adu individual are still smaller in dimensions than the re spective parts of Skull II of Locus L and *Pithe canthropus* (*cf.* Weidenreich, 1937).[3]

As to the face, the parts preserved in Skulls II an III yield a rather good idea of the general structur at least as far as the upper parts are concerned. Th nasal bridge is broad and flat. There is no groov between the root of the nose and the forehead. Th orbit is very low; the lateral border recedes backward below the frontal zygomatic suture. The lacrima fossa is missing in all skulls. The orbit is deep an the superior orbital fissure very small. The chee bone is remarkably high, as high as that of the Rho desia Skull. A canine fossa does not exist and th anterior surface of the frontal process of the maxill

[1] Davidson Black, *Palaeontologia Sinica*, Ser. D, 7: 2 1931.

[2] Franz Weidenreich, *Bull. Geol. Soc. China*, 14: 427-468, 1935.

[3] *Idem.*, *Bull. Geol. Soc. China*, Ting Memorial Volum (in press).

slightly convex and not depressed, as in recent man. The upper jaw therefore must have projected considerably. The palate is broad and high.

Earlier (1935) I was able to demonstrate that a close connection between *Sinanthropus* and certain groups of the present Mongol race could be assumed. The occurrence of the so-called "torus mandibularis" on the inner side of the mandible of some of the *Sinanthropus* jaws as well as on those of recent Mongols, especially Eskimos and Lapps, and furthermore the occurrence of shovel-shaped medial and lateral upper incisors in *Sinanthropus,* as also in modern Mongols, indicate some direct relationship between Peking Man and the Mongol group of recent mankind. Whether or not the broad and flat nose of *Sinanthropus* points to the same direction I do as yet not venture to state. However, in addition there is another conspicuous feature which, I believe, serves as further evidence for the assumption of such a special relationship. All three adult skulls show a large "inca-bone" (*os epactale*) which, it is true, is not confined to the ancient Peruvian natives, as the name suggests, but also occurs in other races of to-day. However, it is much more frequent in the American Indian and Mongol group (up to 7.8 per cent.) than in the latter (up to 2 per cent.).

As to the relation to *Pithecanthropus, Sinanthropus* Skull II of Locus L, together with the fragmentary *Sinanthropus* of Locus I mentioned above, prove incontestably that there is no appreciable difference between *Pithecanthropus* and *Sinanthropus* as far as the general shape and the lowness of the skull caps are concerned. Since it has been assumed that these two *Sinanthropus* skulls belong to female individuals, it is very probable that *Pithecanthropus* also belongs to the same sex, a probability which had already been pointed out by E. Dubois and Hrdlička. The *Sinanthropus* skulls differ from *Pithecanthropus* by only two characters, namely, in that the frontal bone proper is more vaulted in *Sinanthropus,* although its inclination to the glabella-inion line is distinctly more pronounced than in *Pithecanthropus.* Furthermore, the supraorbital ridges of *Sinanthropus* are separated from the forehead by a really broad furrow, while in *Pithecanthropus* they continue gradually to the brow. The latter phenomenon, however, seems to have some connection with the formation of the frontal air-sinuses. In *Pithecanthropus* these sinuses are conspicuously large and extend far lateralward over the roof of the orbit, whereas in all cases of *Sinanthropus* they are very small and closely confined to the interorbital region. I consider this appearance in the case of *Sinanthropus* as an indication of its being more primitive than *Pithecanthropus* and the latter, in spite of the absence of prominent frontal tubera, as a more advanced type of hominid.

Another important fact is disclosed by *Sinanthropus* Skull I of Locus L. This skull is not only the largest of all *Sinanthropus* skulls recovered hitherto (*ca.* 1,200 cc) but at the same time also the highest. Although its general structure and essential details show the same characters as the lowest Skull II of Locus L, yet its greater cranial capacity approaches closely the more primitive representatives of the Neanderthal group. I had earlier (1936)[4] assumed that there must be some relation between *Pithecanthropus* and *Javanthropus soloensis,* the latter resembling the former in several primitive characters. On the other hand, there is no doubt that *Javanthropus* has many peculiarities in common with *Sinanthropus,* as recently demonstrated by C. U. Ariens Kappers (1936)[5] in regard to the endocasts. I should not be surprised if *Pithecanthropus* at some future date should be found to represent nothing else but a special female type of *Javanthropus.* Since *Javanthropus* as a whole represents a very primitive form of Neanderthal Man, the line linking *Pithecanthropus* and *Sinanthropus,* respectively through *Javanthropus* or Neanderthal Man to recent man is continuous. The fact that there may be certain racial deviations does not matter greatly, since the determining factor does not depend on relatively minute differences but on the main course of human development itself.

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EXCHANGES BETWEEN BLOOD PLASMA AND TISSUE FLUID IN MAN

IN previous publications[1] we have shown, with normal men, that brief violent exercise produces a sudden transudation of up to 20 per cent. of the plasma water from the blood to the tissues. The return of the volume and the general concentration of the blood to the resting level follows, approximately, a logarithmic deceleration curve and requires about an hour. In these exchanges the water is accompanied by a small amount of proteins which are highly active osmotically (*i.e.,* their molecular size is small). This does not mean that the capillaries are extraordinarily permeable. The plasma calcium, including the so-called "diffusible" fraction, does not escape across the capillary wall more readily than does protein under these conditions.

The behavior of the sodium concentration in experiments of this type (exhaustion produced in 1 minute) throws further light on the permeability of the capil-

[4] *Idem, Peking Nat. Hist. Bull.,* 10: 4, 281–290, 1936.

[5] C. U. Ariens Kappers, *Jour. Anat.,* 71: 61–76, 1936.

[1] Keys, *Jour. Biol. Chem.,* 105, xlvi, 1934; Keys and Taylor, 1935, *ibid.,* 109, 55; Keys and Adelson, *Amer. Jour. Physiol.,* 115: 539, 1936.

lary wall. In all cases (15 subjects) the sodium concentration in the plasma immediately after work is from 2 to 10 per cent. above the resting level, but the recovery is rapid. In 15 minutes $[Na]_S$ is very nearly at the resting level; at this time the return of water to the blood stream is only 60 to 75 per cent. complete. Apparently, the rate of exchange of sodium across the capillary wall is markedly less than that of water but is still very rapid in comparison with the readjustment of the blood volume.

The behavior of the plasma potassium is very different. Immediately at the end of work $[K]_S$ may be as much as 25 per cent. above the resting level, but it drops precipitously. After 10 or 15 minutes the level is from 5 to 15 per cent. *below* the resting level. $[K]_S$ then begins to rise and exceeds the resting level as much as 20 per cent. at 40 minutes; the resting level is regained in from 1 to 1½ hours. This remarkable cycle is consistently found (6 subjects); it is not due to hemolysis or exchanges with the red cells.

Intravenous injections of adrenalin (0.05 to 0.2 cc of 1 to 1,000 solution) produce a rise in blood pressure and a general hemoconcentration similar to the effect of brief exercise, but the response of $[K]_S$ is different. We have found no initial rise of $[K]_S$ resulting from adrenalin. $[K]_S$ decreases from 4 to 15 per cent. below the resting level within the first few minutes; thereafter $[K]_S$ rises, reaching from 5 to 15 per cent. above the resting level after about an hour.

The exchanges of Na, Ca, H_2O and protein are readily interpreted in terms of osmosis and different rates of diffusion through the capillary walls. From preliminary results this seems also to be true of sulfate and Cl. Such explanations are totally inadequate to account for the potassium exchanges. It may be noted that it is possible the secondary fall and subsequent rise of $[K]_S$ beginning about 8 minutes after exercise may be entirely analogous to the changes in $[K]_S$ following adrenalin; in fact, these delayed effects may be due to a delayed production of adrenalin. However, such a theory would not account for the adrenalin effect itself nor would it throw any light on the immediate effect of exercise on the $[K]_S$.

These results were obtained from duplicate, triplicate and quadruplicate analyses, which agreed within about ± 1 per cent. These experiments will be published *in extenso* in the near future. The potassium method will be published separately.

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THE PLANT ORIGIN OF A VITAMIN D

IN the animal kingdom the vitamin D group is widely distributed, but only in the fishes has it so far been found in great concentration. To account for this, Steenbock and Black[1] suggested that the vitamin might originate from the solar irradiation of plankton. Attempts to support this hypothesis have so far been consistently negative in phytoplankton,[2,3] although results of doubtful significance have been reported with zooplankton.[4,5]

Spectrographic studies[6] on the presence of ultra-violet light below the surface of the sea, made at the Tortugas Islands where the water is very clear, have shown a high intensity of relatively short wave-lengths in the first three feet. In the light of these findings, the Sargassum weed seemed a logical form to investigate for the presence of vitamin D. This alga grows at shallow depths in the clear waters of the Caribbean. Although there is doubt as to whether some forms originate at the bottom and later lose their attachments, all species float and grow on the surface for some months, small sprigs at times protruding as much as 10 cm above the water.

We therefore tested the lipin fractions of *Sargassum* for antirachitic properties. Samples collected in the Gulf Stream off Cape Hatteras during May and off the Tortugas during July have yielded oils (in amounts corresponding to 2.5 and 3.0 per cent., respectively, of the dry material) which are definitely curative for rickets. The Sargassum from the Tortugas, after several washings in fresh water to remove accompanying animal forms, furnished a lipoidal mixture which was active in rat-doses of less than 3 mg divided over 8 days. Oils from *Ulva* and *Laminaria* collected off Cape Cod during August were inactive at much higher dosage levels. More exhaustive assays are in progress, and the determination of the rat-chicken activity ratio is planned.

The product from the Hatteras collection of *Sargassum* has been subjected to chemical examination. The unsaponifiable fraction, amounting to 28 per cent. of the oil, yielded about 20 per cent. of a colorless crystalline sterol apparently identical with the fucosterol isolated by Heilbron *et al.*[7] from *Fucus vesiculosus*. This sterol, which was purified by crystallization only, without the use of charcoal, exhibits no selective absorption in the ultra-violet region, and therefore[8] contains neither a vitamin nor a provitamin of the D

1 Steenbock and Black, *Jour. Biol. Chem.*, 64: 263, 1925.
2 Leigh-Clare, *Biochem. Jour.*, 21: 368, 1927.
3 Drummond and Gunther, *Nature*, 126: 398, 1930; *Jour. Exp. Biol.*, 11: 203, 1934.
4 Belloc, Fabre and Simonnet, *Compt. Rend.*, 191: 160, 1930.
5 Copping, *Biochem. Jour.*, 28: 1516, 1934.
6 Darby, Johnson and Barnes, Papers from the Tortugas Laboratory, in press.
7 Heilbron, Phipers and Wright, *Jour. Chem. Soc.*, 1934: 1572.
8 Gillam and Heilbron, *Biochem. Jour.*, 30: 1253, 1936.

roup. Such a substance, however, is present in non-rystalline fractions, which display a distinct absorp-ion band at 260 mμ superimposed upon the absorption f carotenoids and other accompanying substances.

Sargassum collected at its site of origin is relatively ree from closely associated foreign organisms, even rotozoa, and the "leaves" are clear and intact. How-ver, a fairly large colony of free-swimming shrimps nd fishes is present. Much of the weed finds its way nto the Gulf Stream, and during its northward assage becomes heavily infested with invertebrates. amples taken north of Hatteras present a complex icture of plant and animal commensalism: the stems re covered with masses of the long-necked barnacle (*Lepas*) and immense numbers of mollusks with their ggs. Several types of shrimps and fishes abound. he "leaves" are now extensively damaged and often ompletely missing.

Little imagination is needed to visualize the progressive transfer of the vitamin from the plant to the small animals, thence to the larger predatory fishes which follow the floating colonies. Such a process, combined with the drift of the Gulf Stream, may well contribute to the wide but unequal distribution of vitamin D in marine fish oils. Of interest in this connection is the report[9] that the cod livers taken from the White Sea and Bear Island region are consistently lower in vitamin D than those taken off Iceland in waters which are more accessible to the Gulf Stream.

The occurrence in plants of a vitamin D, in common with other vitamins, must now be recognized. The frequent association of vitamins A and D in fish liver oils is on these grounds easily understandable.

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[9] Lovern, *Chem. Ind.*, 56: 75, 1937.

SCIENTIFIC APPARATUS AND LABORATORY METHODS

THE USE OF BROMINE IN THE STERILIZATION OF FRUITS AND SEEDS

Sterile seedlings may be grown from seeds treated with any one of a number of substances. Calcium hypochlorite, as used by Wilson,[1] is perhaps the most popular of these, though mercuric chloride also has many advocates. An appreciable amount of time is needed for the mixing and filtering of bleaching powder, and the strength of the resulting solution is dependent on the age and condition of the powder. Mercuric chloride may cling to the seed coats and later injure the seedlings. A satisfactory sterilizing medium has been found in bromine, which I have used for more than two years with great success.

The best results have been gained with bromine water, which is diluted to 1/10 its original strength and poured over the seeds in a container, which is then tightly stoppered. Of course, care must be taken not to breathe the poisonous fumes of the bromine water. When the seed container is opened after sterilization, the weak solution does not fume sufficiently to be troublesome. Other dilutions may be used, but I have found it convenient to vary the length of time of sterilization rather than change the concentration of the sterilizing substance. The tolerance of seeds varies; oats are injured by exposures of more than one half hour, but corn, cabbage, radish and sunflower withstand an hour or more of treatment.

Bromine water has been used also in sterilizing fruits from which embryos were removed for growth in culture[2] and the chances of securing sterile embryos increased considerably thereby. In the tomato, immature ovules, even, may be removed from fruits and treated for one half hour without injury to the young embryos.

Fragments of stems and roots, treated in this manner, have been grown in sterile culture. Even leaves and flower buds have proved sterile in culture after bromine treatment, though it is not always possible to secure sterilization without fatal injury to these delicate structures.

No rinsing is required after bromine treatment, but the structures are placed at once on sterile filter paper, in liquid or on agar, as required. The bromine soon disappears, leaving no trace to injure later growth.

Bromine water will keep for long periods if stored in the dark. Shaking up the excess bromine in the water a few minutes before use insures a bromine content of satisfactory uniformity.

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[1] J. K. Wilson, *Amer. Jour. Bot.*, 2: 420–425, 1915.

[2] C. D. La Rue, *Proc. Nat. Acad. Sci.*, 22: 201–209, 1936; *Bull. Torr. Bot. Club*, 63: 365–382, 1936.

TO KEEP CULTURE-MEDIA FROM DRYING OUT

One of the problems of the small clinical laboratory and only a lesser problem in other laboratories is that of keeping culture-media ready for use, particularly Loeffler's medium, blood-agar slants and blood-agar plates. For this purpose and for preservation of stock cultures we have found a material called parafilm (made by the Marathon Paper Mills Co., Rothschild, Wisconsin) so useful that we wish to bring it to the attention of others. A square of this film pressed down on the mouth of a culture tube, the cotton plug

having first been pushed in, keeps the slant from drying out for weeks at incubator temperature and indefinitely at room temperature. It is equally efficient in keeping the volume of a broth tube or flask unchanged. The advantage over wax or paraffin is that the seal is readily stripped off and the cotton plug remains perfectly manageable. An inch-wide strip carried around the cover of a Petri dish and pressed down on the bottom of the dish allows prolonged incubation of a plate culture. Poured plates thus sealed are stacked for storage with waxed paper between to keep them from sticking together. The security of the seal may be seen in the following experiment: (1) 10 cc of alcohol in a graduated centrifuge tube lost nothing in volume in four days, during which time the same quantity in a cotton-stoppered tube, both in the 37° incubator, went down to 7 cc; (2) a tube of water at 54° kept the level unchanged for nine days, during which time the control went down an inch.

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DECLIVITY MAPS

GEOGRAPHERS are not alone in finding maps to indicate the degree of slope for a given land surface extremely useful. These maps are not common; and hence many researchers have gone to the field for this information. This procedure is unnecessary when large scale topographic maps with a small contour interval are available. Therefore, this brief paper deals with a method of gathering the essentials requisite for the construction of declivity maps from topographic maps.

The two essential data used in determining slope information are included in topographic maps. If one is to inspect below the diagrammatic, vertical section of a hill, prepared to illustrate certain features in the construction of a topographic map, it is obvious that the requisite information for the declivity map is available.

If one wishes to determine the slope of the land between A and C, it may be calculated by solving for angle BCA, whose tangent is calculated by the distance AB as 50 feet (contour interval) and BC as 75 feet (by measure). In like manner the angles of DEC, GFH and IHJ may be ascertained. It follows then that these angles are the respective slope angles along the line XX′. To secure slopes elsewhere on the map, one has only to measure the distance between contours and substitute this formation with the contour interval, as indicated in the above method.

Place the computed angles mid-way between the contours where the slope has been determined. When

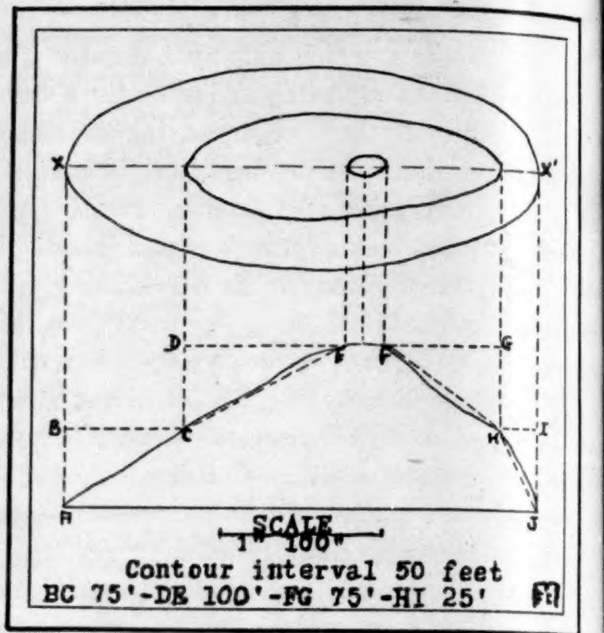

FIG. 1

the slope information has been recorded, generaliz[e] this information by the conventional isopleths, familiar to geographers.

The number of observations will be governed by the degree of detail necessary for a given problem. Like all isoplethic maps, generally speaking, the greater the number of observations used for the map, the more faithful the map is to the truth.

It is suggested that a table be prepared with slope angles indicated as equivalents of the data discussed. The number of items necessary for a table will be governed, of course, by the degree of detail desired.

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